Jan. 29, 2005 – Continental Outflow, TES & MLS runs, and Vortex Sampling

Summary:

We satisfied all of our objectives on this flight. Highlights included:

- Profiling and boundary-layer sampling over the Atlantic downwind of east coast cities in mostly clear conditions, with up to 1 ppbv NO concentrations in the boundary layer
- Run along TES nadir track with optically thin cirrus much of the way, but clear-column conditions for the northernmost two TES points
- Run north along the MLS track crossing the vortex edge with clear evidence of vortex ozone depletion, evidence of filamentation above 23 km, and highly variable ozone mixing ratios along the MLS track
- Approximately 50-minute sun run looking southwest at the airmass sampled earlier by Aura and the DC-8

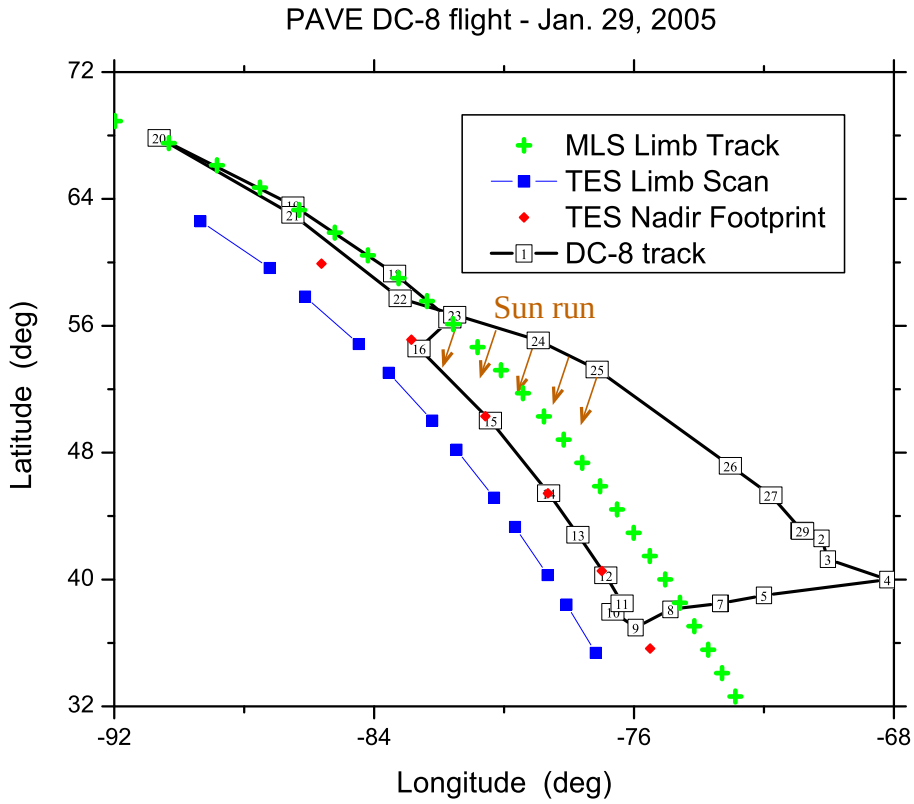

Figure 1: DC-8/Aura coordination (courtesy Bob Herman and Nathaniel Livesey)

Flight plan:

Objectives include validation of Aura measurements (O_3, NO_2, ClO, HNO_3, etc.); sampling pollution outflow along the east coast; sampling tracers in the tropopause region; measuring ClO, O_3, etc.; and sampling ozone and chlorine species in the lower stratosphere at the edge of the vortex.

1. Profile over water along the east coast to sample outflow from U.S. (particularly NO_2, HNO_3, and CO).

2. Over fly Wallops ozonesonde.

3. Fly along TES nadir ascending track near the tropopause up to the vicinity of Toronto.

4. Jog over to the MLS track and fly as far north as possible, hopefully into the vortex. The Aura overpass is at 1823 UT, which is shortly after we begin the MLS track.

5. On return, execute sun run, sampling air previously sampled by Aura and the DC-8.

The estimated duration is 10 hours.

Report:

Takeoff was approximately on time (08:23:44 local). As we headed out off the coast, only a few thin cirrus clouds were visible on the distant horizon. As we headed toward the easternmost waypoint, we were approaching a stratocumulus deck, so we cut short and turned southwest. Along the southwest leg over the Atlantic, it was clear directly below the aircraft, but there were patchy boundary layer cumulus off the port side. During the boundary-layer run, we had clear skies overhead except for a few puffy clouds at the top of the boundary layer, and aged contrails at the southern end of the track.

NO_2 measurements in the 1 kft boundary-layer run increased from 500 pptv to 1 ppbv then dropped to less than 100 pptv when we ascended out of the boundary layer.

As we ascended and headed toward Wallops, we had patchy, thin cirrus and aged contrails above. Along the southern end of the TES run, there were geometrically thick (5-10 km), but optically thin (ground visible on nadir video) cirrus below. Hopefully, these clouds were optically thin enough to not interfere with TES retrievals. At 36 kft we appeared to be above the clouds, but we were still in consistently ice supersaturated air with ozone concentrations reaching about 100 ppbv. As we ascended to 37 kft, we stayed in ice supersaturated air up to the cold point at about 36.7 kft and -66 C. At 37 kft, we were well within the stratosphere (O_3 = 185 ppbv).

We cleared the cirrus clouds as we approached James Bay and then cleared a stratus deck around the middle of James Bay. It appeared that we would have clear-column conditions for the TES measurement point at the south end of Hudson Bay about 30 minutes before the Aura overpass.

Sections of the flight leg over James Bay with high in situ ozone concentrations corresponded to filaments of high potential vorticity at flight level in the forecasts.

ASUR reported considerable ClO concentrations in the lower stratosphere poleward of about 62 degrees latitude along the MLS run. At about 64 degrees, AROTAL detected a blob of ozone-depleted air at about 23-24.5 km, and ozone concentrations steadily decreased as we continued north. The higher blob appeared to be a filament broken off from the vortex (see Figure 2). We had to turn back at about 68°N in order to be on time for the sun run. The minimum ozone concentrations at 20 km were about 2.4 ppmv. No PSCs were observed.

When we ascended to 40 kft over Hudson Bay, the HNO_3 concentration exceeded 3.5 ppbv.

Lastly, we did an approximately 50-minute sun run with successful FTS measurements, then returned to Pease.

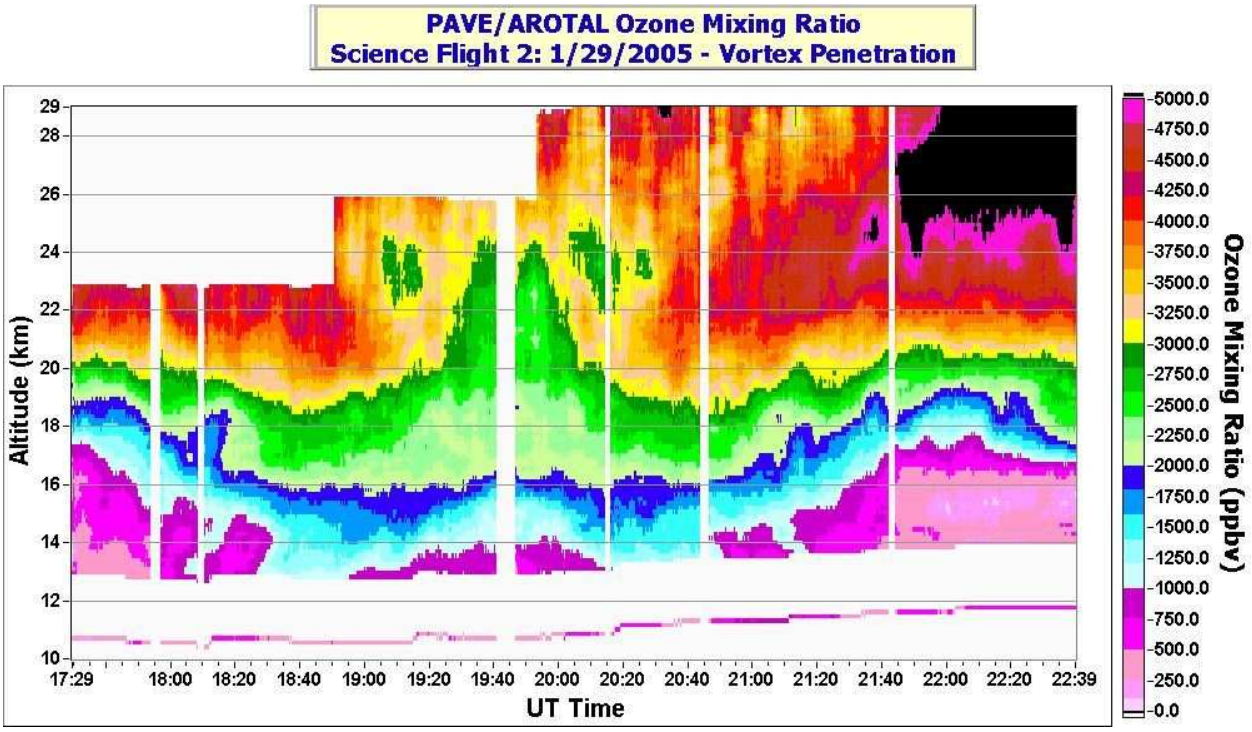

Figure 2: AROTAL curtain plot showing ozone concentration as we went into and back out of the vortex.

Instrument status:

- AROTAL: McGee–damage in boundary-layer run, recovered before reaching vortex
- DIAL: Browell–good flight
- FTS: Coffey–good sun run
- CAFS: Shetter–apparently fine
- MTP: Mahoney–good flight
- ASUR: Notholt–worked well
- nadir CO_2: Heaps–good flight
- FastOz: Avery– ‘most excellent flight”
- DACOM: Diskin–good measurements throughout flight
- DLH: Diskin–good flight, interesting structure
- SAGA: Dibb–worked well
- BNOD: Cohen–good flight
- ICATS: Yarborough–worked fine
- COBALT: Podolske–good flight